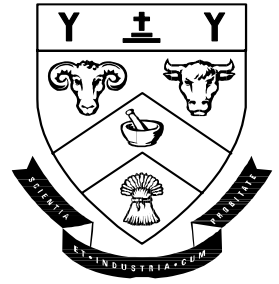


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T e W h a r e W ā n a k a O A o r a k i



**MEASURING INTERFERENCE WITH POSSUM
BAIT BY NATIVE BIRDS**

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1. Summary

1.1 Project and Client

This study (Project No. R-80562) aimed to quantify the risk to free-ranging, native birds from four new types of bait, which will be used with micro-encapsulated zinc phosphide (Zn_3P_2) for the control of possum. The work was done by Lincoln University and Pest Tech. Ltd during May 2002 and was funded by the Animal Health Board.

1.2 Objectives

To quantify the risk to native bird species from new cereal, paste, polymer and gel possum bait by:

- calculating the palatability of each new bait type compared with an existing possum bait (cereal No. 7 bait);
- measuring the mean consumption of each new bait type compared with an existing possum bait (cereal No. 7 bait); and
- observing and recording the behaviour of native birds for each new bait type compared with an existing possum bait (cereal No. 7 bait).

1.3 Methods

Paired trays of test and control bait (50 g) were presented to the birds (over a seven-day period) at feeding stations on the 'Wattle track'. Bait palatability was calculated as the percentage of test bait consumed relative to the total amount of bait eaten (i.e. control+test bait). The control was cereal No. 7 bait, which is widely used for 1080 aerial and ground control of possum. In addition to this, one of the feeding stations was observed continuously for one hour each day. During the observation period all bird activity relating to both bait types was recorded. These activities were broadly categorised into startled, look, move and/or push, and peck and eat.

1.4 Results

All of the new bait types were less palatable than the control bait. Analysis of the individual differences indicated that the paste and polymer bait types were the least palatable and both were consumed in significantly lower amounts than the cereal No. 7 control bait.

Unfortunately we were unable to collect much observation data, as the birds were scared away by the approaching observer.

1.5 Conclusions

The results of this study suggest that all the new bait types (developed for eventual use with micro-encapsulated Zn_3P_2) should not increase the risk of accidental poisoning for non-target, native bird species. All the new bait types were less palatable than the control bait and the overseas toxicity data indicates that the smaller bird species (i.e. passerines) are less susceptible to Zn_3P_2 than 1080.

1.6 Discussion

Whilst the results of this study are positive, our estimates of the poisoning susceptibility are somewhat 'crude'. Certainly the overseas non-target studies support our findings with few non-target bird deaths reported following the broadcast application of Zn_3P_2 rodent bait. This low non-target mortality is one of the key reasons why Zn_3P_2 is currently being re-registered by the US Environmental Protection Agency (USEPA) for broadcast use as a rodenticide. Ironically, the USEPA has cancelled the rodenticide use of Compound 1080 and they are

currently concerned about the field use of anticoagulants and cholecalciferol because of potential primary and secondary hazards to non-target species.

1.7 Recommendations

Given the results of this study, we recommend that:

- further research to facilitate the product registration of Zn_3P_2 should proceed;
- in future control operations, managers should use either the paste or polymer bait types in areas with high numbers of 'at-risk' bird species; and
- future studies attempting to observe bird behaviour around bait feeding stations should use remote video cameras to avoid any observer bias.

2. Introduction

This study (Project No. R-80562) aimed to quantify the risk to free-ranging, native birds from four new types of bait, which will be used with micro-encapsulated zinc phosphide (Zn_3P_2 ; *trizinc diphosphide*) for the control of possum. The work was done by Lincoln University and Pest Tech. Ltd during May 2002 and was funded by the Animal Health Board (AHB).

3. Background

Six poisons are currently registered for possum control in New Zealand, with sodium monofluoroacetate (1080) being the most extensively used. This toxin can be incorporated into various bait types and has been shown to be an extremely cost-effective method of initially removing >90% of a possum population (Eason *et al.* 1994). However, due to ongoing public opposition to use of 1080 (Eason 1995), the AHB has funded extensive research to identify cost-effective alternatives for controlling possum. Opposition to 1080 is a manifestation of the perceived risk to human health, the risk of secondary poisoning for dogs (Meenken and Booth 1997), the incidental poisoning of feral deer (Fraser and Knightsbridge 1995), and the risk of primary poisoning for native birds (Spurr 1994).

As a result of this 'alternative toxin' research, Zn_3P_2 was identified as a potential replacement for 1080. Zn_3P_2 was selected because the toxin is widely used in Asia and Europe, and is registered by the US Environmental Protection Agency (USEPA) for broadcast use to control rodents that impact on agricultural production. Several field trials have reported low numbers of non-target deaths from primary poisoning (Johnson and Fagerstone 1994) and as Zn_3P_2 doesn't accumulate in animal tissue the potential for secondary poisoning of predators and/or scavengers is also low (Hill and Carpenter 1982; Joermann 1998). Landcare Research initially evaluated Zn_3P_2 on caged possums during 1998–99 (Wickstrom and Eason 1998; O'Connor *et al.* 1999). Although the toxin proved highly efficacious when administered by oral gavage, possums either refused bait-containing Zn_3P_2 or ate small, sub-lethal quantities of toxic bait. Unfortunately bait-containing Zn_3P_2 has an abhorrent garlic taste and/or odour that is aversive to possums. Initial attempts by Landcare Research to micro-encapsulate Zn_3P_2 were unsuccessful, however the toxin has since been encapsulated by Pest-Tech Ltd. (Henderson 1999). Once micro-encapsulated Zn_3P_2 presents fewer risks to human health than 1080 because the toxin cannot be absorbed through the skin or inhaled as dust, and is not able to be dissolved in drinking water.

Subsequent research conducted by Pest-Tech Ltd. and Lincoln University has demonstrated that micro-encapsulated Zn_3P_2 paste bait is extremely effective at killing both captive and free ranging possums (Ross *et al.* 2000). Whilst the paste bait is suitable for ground-laid application, different bait types were required for other control techniques. Accordingly, Pest-Tech Ltd. has now developed cereal (suitable for aerial control), gel and long-life polymer bait (both suitable for bait stations) containing micro-encapsulated Zn_3P_2 (Henderson *et al.* 2002; Ross *et al.* in press). Existing possum bait is not suitable for micro-encapsulated Zn_3P_2 as the bait manufacturing process can damaged the capsules. Whilst this research has clearly demonstrated the potential of Zn_3P_2 , the ultimate goal is to produce new possum bait suitable for product registration. However, before a new toxin can be registered for possum control in New Zealand, it is important to evaluate the environmental safety of the bait. The research outlined in the remainder of this report was conducted to assess the risk to non-target native bird species from use of all the new bait types intended to be used with micro-encapsulated Zn_3P_2 .

4. Objectives

To quantify the risk to native bird species from new cereal, paste, polymer and gel possum bait by:

- calculating the palatability of each new bait type compared with an existing possum bait (cereal No. 7 bait);
- measuring the mean consumption of each new bait type compared with an existing possum bait (cereal No. 7 bait); and
- observing and recording the behaviour of native birds for each new bait type compared with an existing possum bait (cereal No. 7 bait).

5. Methods

The feeding trial commenced on 13 May 2002 and was completed by 19 May 2002. This trial was undertaken with free-ranging birds on Tiritiri Matangi Island, which is a 220 ha sanctuary that lays 4 km off Auckland's Whangaparoa Peninsula. This island provides a 'pest-free' habitat for a number of rare and endangered species. A total of 27 endemic or indigenous bird species are known to breed on the island and this includes several passerines that are considered vulnerable to 1080 possum bait, such as the tomtit (*Petroica macrocephala*) and NI robin (*Petronica australis longipes*).

Measured amounts (50 g) of non-toxic cereal No. 7 bait were paired with: i) non-toxic cereal bait; ii) non-toxic gel bait; iii) non-toxic paste bait; and iv) non-toxic polymer bait. The cereal No. 7 was used as the control as it is widely used in 1080 possum control operations and is considered to be an 'industry standard' (Ross *et al.* 2002). The cereal No. 7 bait was supplied by Animal Control Products, Wanganui and contained 0.075% Bayer V200 green dye and 0.1% cinnamon oil as a bird deterrent (Caithness and Williams 1971; both supplied by Bush, Boake and Allen, Auckland). All the new bait types also contained 0.075% Bayer V200 green dye and then either 0.1% cinnamon oil or 0.1% orange essence (supplied by Terry Holdings, Auckland). Bait palatability was determined using a standard 'two-choice' test (Grote and Brown 1971) and calculated as the percentage of test bait eaten relative to the total amount of bait eaten. A value of 50% therefore, demonstrates that the test bait was of equal palatability to the control. Comparisons in bait palatability between bait types were made using a student's *t* test.

The 'Wattle track' was used as a transect and feeding stations were placed at 50 m intervals on alternative sides of the track (Appendix 1). The Wattle track is considered the best place on the Island to see birds with the tui (*Prothemadera novaeseelandiae*), saddleback (*Philesturnus carunculatus*), bellbird (*Anthornis melanura*), whitehead (*Mohoua albicilla*), NI robin and tomtit commonly viewed in this area. All feeding stations were placed 20 m from the track edge, so that visitors moving down the track wouldn't disturb the birds. Each treatment was left out for a four-hour period in the morning with fresh bait put out in the afternoon. This continued for a seven-day period, so that each feeding location had 13 combinations of treatment and control bait (bait was not put out on the last afternoon). Bait types were randomly allocated amongst the feeding locations to prevent the birds becoming accustomed to a particular combination of treatment and control bait. All trial food was weighed prior to being given to the birds and directly after the four-hour period. So that all consumption figures could be standardised for dehydration or hydration, additional baits (50 g for each bait type) were also put out daily and measured for weight loss or gain. These control baits were placed in a wire cage approximately halfway along the Wattle track and 20 m from the track edge.

Once the bait had been put out, one of the feeding stations was observed continuously for one hour each day. During the observation period all bird activity relating to both bait types was recorded. These activities were broadly categorised into startled, look, move and/or push, and peck and eat.

6. Results

6.1 Palatability

All of the new treatment bait types were less palatable than the control bait (Table 1). Analysis of the individual bait differences indicated that the paste and polymer bait types were the least palatable and both were consumed in significantly lower amounts than the cereal No. 7 control bait.

Table 1. Palatability of different non-toxic possum bait presented in a two-choice feeding test.

Treatment	Control	Palatability	P-value
Cereal	Cereal No.7	39.53%	0.57
Gel	Cereal No. 7	23.09%	0.16
Paste	Cereal No.7	9.91%	0.008
Polymer	Cereal No.7	20.71%	0.048

6.2 Mean consumption

The mean amount of bait consumed (per four-hour feeding period) followed a similar pattern to the palatability results, with the birds consuming less of the new bait types compared with the control bait. As a general observation, the mean consumption of the new bait types was less than 5 g per feeding period. In contrast, the mean consumption of the cereal No. 7 bait was up to three times higher (17 g).

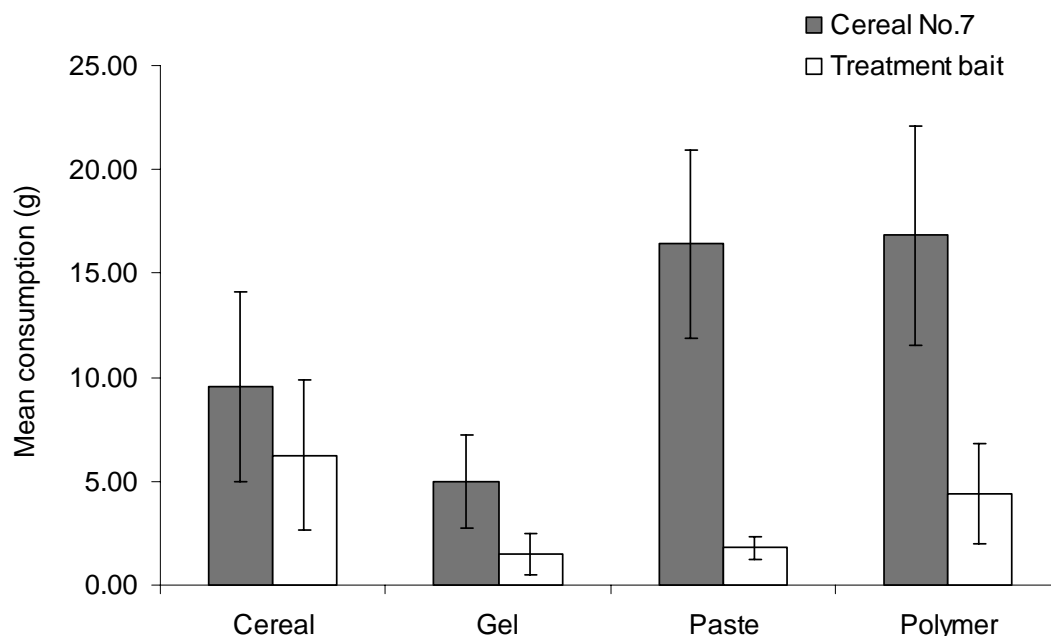


Figure 1. Mean consumption (g) of possum bait during a daily four-hour feeding period (\pm SE). All treatment bait was presented with cereal No. 7 in a two-choice feeding test.

6.3 Bird activity

There was limited observed behaviour around the baits (Table 2). Most birds were scared away by the approach of the observer and would not return to the feeding station during the observation period. Interestingly, the only birds observed eating food focused on the gel and paste bait (see palatability results).

Table 2. Bird activity in relation to treatment bait (*p=polymer bait, pa=paste bait, g=gel bait, c=cereal bait, co=control bait*).

Bird Species	Startled					Look					Move/ Push					Peck and Eat				
	p	pa	g	c	co	p	pa	g	c	co	p	pa	g	c	co	p	pa	g	c	co
Quail (<i>Lophortyx californicus</i>)			1	1							5	1				5	1			
Kakariki (<i>Cyanoramphus</i> sp.)										5										
Robin (<i>Petronica australis</i>)										2										
Fantail (<i>Rhipidura fuliginosa</i>)					1															
Pukeko (<i>Porphyrio melanotus</i>)				1																

7. Conclusions

The risk of accidental poisoning has previously been expressed as:

$$Risk = Hazard \times Exposure \text{ (Morgan 1999)}$$

In the above study, we have directly assessed the exposure (i.e. bait consumption) of free-ranging, native bird species to non-toxic versions of new possum bait. The hazard for a non-target species is determined by the sensitivity of that species to the toxin (i.e. the LD₅₀ dose).

7.1 Exposure

The above research demonstrated that all of the new bait types (developed for eventual use with Zn₃P₂) were less palatable than the control bait. This is a positive result as cereal No. 7 bait is widely used for aerial and ground control of possum. Essentially this means that we would not increase the non-target consumption of possum bait by using the new bait types. If we focus on the individual palatability scores, the results clearly indicate that the paste and polymer bait types are the least palatable to birds. Accordingly, these should be favoured in areas where the risk of accidental bird poisoning is considered to be high (e.g. mainland island sanctuaries).

7.2 Hazard

Obviously we were unable to use toxic bait throughout the feeding trial, as this would have put some endangered birds at risk. Whilst the consumption of any new possum bait is important, the susceptibility of non-target bird species to the Zn₃P₂ toxin is also important. For example, the fact that a new possum bait has low palatability is of little use if non-target bird species have heightened susceptibility to the new toxin used in the bait. Whilst we do not have Zn₃P₂ LD₅₀ data for native bird species, we do have data for several introduced bird species. Accordingly we can use this data to compare the likely hazards of 1080 and Zn₃P₂, for different-sized bird species, using a methodology developed by Lloyd and McQueen (2000).

Table 3. Estimated LD₅₀ for bird species consuming possum bait containing sodium monofluoroacetate (1080).

Species	Body mass (g)	LD ₅₀ ¹ of 1080 (µg/g ⁻¹)	Bait conc. (µg/g ⁻¹)	Estimated LD ₅₀ dose (g)
Sparrow (<i>Passer domesticus</i>)	30	2.82	1500	0.06
Blackbird (<i>Turdus merula</i>)	70	9.5	1500	0.44
Quail (<i>Lophortyx californicus</i>)	140	3.0	1500	0.28
Pheasant (<i>Phasianus colchicus</i>)	1000	6.07	1500	4.05
Mallard duck (<i>Anas platyrhynchos</i>)	1100	5.61	1500	4.41

¹ Eisler 1995

Table 4. Estimated LD₅₀ for bird species consuming possum bait containing zinc phosphide.

Species	Body mass (g)	LD ₅₀ ¹ of Zn ₃ P ₂ (µg/g ⁻¹)	Bait conc. (µg/g ⁻¹)	Estimated LD ₅₀ dose (g)
Sparrow (<i>Passer domesticus</i>)	30	20-50 ²	15000	0.07
Blackbird (<i>Turdus merula</i>)	70	75-316	15000	0.91
Quail (<i>Lophortyx californicus</i>)	140	14	15000	0.13
Pheasant (<i>Phasianus colchicus</i>)	1000	9-27	15000	1.2
Mallard duck (<i>Anas platyrhynchos</i>)	1100	36-67	15000	3.78

¹ Johnson and Fagerstone 1994

² When a range value was supplied, I have calculated the dose using a midpoint value.

These tables indicate that the susceptibility of an individual bird species to both toxins is strongly correlated with body size (see: McIlroy 1984). In particular, the birds most at risk of poisoning will always be the smaller species such as the sparrow, which only needs to eat a small amount of bait to consume a LD₅₀ dose. Overall, these very ‘crude’ estimates indicate that the smaller birds have a lower susceptibility to the Zn₃P₂ toxin than 1080.

8. Discussion

Most of the new methodology used in this trial for assessing the exposure (i.e. bait consumption) of birds to a new possum bait worked well in the field. As detailed in a previous AHB report (Ross *et al.* 2002), it is important to conduct such studies using free-ranging populations of native birds who will actually be exposed to bait during possum control operations. Unfortunately, the observation part of this trial was unsuccessful and requires further refinement. In previous studies using captive birds, it was easy to observe behaviour around bait material and this data was very informative. In the future, I believe that we need to set up time-lapse video equipment at the feeding stations. In this trial, it became obvious that the presence of the observer kept birds away. The consumption data indicates that birds were feeding at the unobserved stations and it would have been useful to document their behaviour.

The main problem with the estimation of the poisoning hazard (i.e. susceptibility) is extrapolating the results to native bird species. For example, individual LD₅₀ values are variable and can be influenced by prior exposure to the toxin, the physiological condition of the bird, the availability of alternative food sources, and the ability of the bird to regurgitate treated bait material (Johnson and Fagerstone 1994). There is also significant variation amongst related taxa. For example, the blackbird (*Turdus merula*; an introduced passerine) has a calculated 1080 LD₅₀ of 9.5 µg/g⁻¹, which is three times higher than the house sparrow (*Passer domesticus*; another introduced passerine) with a calculated 1080 LD₅₀ of 2.82 µg/g⁻¹ (McIlroy 1994). Other research also suggests that passerines are more sensitive to 1080 than non-passerines, due to their generally higher metabolic rate. These factors make it extremely

difficult to comment on the susceptibility of individual birds that we have LD₅₀ data for, let alone related and non-related native bird species. These concerns also apply to the Zn₃P₂ calculations. For example, the LD₅₀ dose for the red-winged blackbird (*Agelaius phoeniceus*) is in the 24-178 µg/g⁻¹ range compared with the tricoloured blackbird (*Agelaius tricolour*), which is in the 75-316 µg/g⁻¹ range.

In terms of assessing the likely hazard of Zn₃P₂ poisoning the estimates calculated above suggest that Zn₃P₂ should not pose any increased hazard to non-target birds, particularly the small forest-floor feeding passerines, who have been found dead following 1080 possum control (Spurr 1994). This hypothesis is supported by several toxicity (LD₅₀) studies, which indicate that the smaller passerines are less sensitive to Zn₃P₂ than other groups of birds (e.g. waterfowl and gallinaceous birds). This hypothesis is also supported by several non-target studies conducted in rangeland habitat (primarily occupied by passerines), with only one isolated case of avian mortality documented (Johnson and Fagerstone 1994). There has been Zn₃P₂ bird mortality reported in studies conducted in other habitat (e.g. orchards, ditch banks, sugarcane etc.); however, the incidence is low and any deaths were generally attributed to misuse, such as incorrect bait concentration or an inappropriate application rate (Johnson and Fagerstone 1994).

As a final point, Zn₃P₂ is considered to be one of the safest rodenticides currently available and is being re-registered by the USEPA for broadcast use (Fagerstone, K A 2002, pers. comm.). The continued use of Zn₃P₂ in the USA is primarily the result of the positive field studies, which have demonstrated that there are few non-target deaths, when rodenticides containing Zn₃P₂ bait are correctly applied (Johnson and Fagerstone 1994). Ironically, the rodenticide use of Compound 1080 has been cancelled by the USEPA and they are currently concerned about the field use of anticoagulants and cholecalciferol because of potential primary and secondary hazards.

9. Recommendations

Given the results of this study, we recommend that:

- further research to facilitate the product registration of Zn₃P₂ should proceed;
- in future control operations, managers should use either the paste or polymer bait types in areas with high numbers of 'at-risk' bird species; and
- future studies attempting to observe bird behaviour around bait feeding stations should use remote video cameras to avoid any observer bias.

10. Acknowledgements

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11. References

- Caithness, T. A., and G. R. Williams. 1971. Protecting birds from poisoned baits. *New Zealand Journal of Agriculture* **122**:38-43.
- Eason, C. T. 1995. Sodium monofluoroacetate (1080): An update on recent environmental toxicology data and community concerns. Pages 39-43 in *Proceedings of the 10th Australian Vertebrate Pest Control Conference*, Hobart. Australia

- Eason, C. T., C. M. Frampton, R. Henderson, and D. R. Morgan. 1994. The advantages and disadvantages of sodium monofluoroacetate and alternative toxins for possum control. Pages 159-165 in A. A. Seawright and C. T. Eason, editors. *Proceedings of the science workshop on 1080*. The Royal Society of New Zealand, Wellington, New Zealand.
- Eisler, R. 1995. *Sodium monofluoroacetate (1080) hazards to fish, wildlife, and invertebrates: A synoptic review*. Contaminant Hazard Reviews Report 30, National Biological Service, U.S. Department of the Interior, Laurel, Maryland, USA.
- Fraser, K. W., and P. J. Knightsbridge. 1995. *The effectiveness of aerial 1080 poisoning for possums with and without pre-feeding*. Contract Report LC9596/39, Landcare Research (NZ) Ltd., Lincoln, New Zealand.
- Grote, F. W., and R. T. Brown. 1971. Conditioned taste aversions: Two-stimulus tests are more sensitive than one-stimulus tests. *Journal of Behavioural Research Methods and Instrumentation* **3**:311-312.
- Henderson, R. J. 1999. *The efficacy of baits containing micro-encapsulated zinc phosphide on captive bush-tail possums*. Unpublished Pest Solutions Contract Report PS9900/01, Prepared for The Animal Health Board. Lincoln New Zealand
- Henderson, R. J., C. M. Frampton, and J. G. Ross. 2002. *Cereal bait containing zinc phosphide for the control of possums*. Unpublished Pest Tech Contract Report PS2002/06, Prepared for the Animal Health Board. Lincoln, New Zealand
- Hill, E. F., and J. W. Carpenter. 1982. Responses of Siberian ferrets to secondary zinc phosphide poisoning. *Journal of Wildlife Management* **46**:678-685.
- Joermann, G. 1998. A review of secondary poisoning with rodenticides. *Bulletin OEPP/EPPO Bulletin* **28**:157-176.
- Johnson, G. D., and K. A. Fagerstone. 1994. *Primary and secondary hazards of zinc phosphide to non-target wildlife - A review of the literature*. DWRC Research Report No. 11-55-005, United States Department of Agriculture, Denver, USA.
- Lloyd, B. D., and S. M. McQueen. 2000. An assessment of the probability of secondary poisoning of forest insectivores following an aerial 1080 possum control operation. *New Zealand Journal of Ecology* **24**:47-56.
- McIlroy, J. C. 1984. The sensitivity of Australian animals to 1080 poison. VII. Native and introduced birds. *Australian Wildlife Research* **11**:373-386.
- McIlroy, J. C. 1994. Susceptibility of target and non-target animals to 1080. Pages 90-96 in A. A. Seawright and C. T. Eason, editors. *Proceedings of the science workshop on 1080*. The Royal Society of N.Z., Wellington, New Zealand.
- Meenken, D. R., and L. Booth. 1997. The risk to dogs of poisoning from sodium monofluoroacetate (1080) residues in possums. *New Zealand Journal of Agricultural Research* **40**:573-576.

- Morgan, D. R. 1999. Risks to non-target species from use of a gel bait for possum control. *New Zealand Journal of Ecology* **23**:281-287.
- O'Connor, C. E., D. R. Morgan, and M. Wickstrom. 1999. *The development of alternatives to 1080 for possum control*. Landcare Research Contract Report No. LC 9899/64. Lincoln, New Zealand.
- Ross, J. G., C. M. Frampton, and P. Gardner. 2002. *Assessing bird interference with apple bait*. Unpublished Pest Tech Contract Report PS2002/07, Prepared for the Animal Health Board. Lincoln, New Zealand.
- Ross, J. G., C. M. Frampton, and R. J. Henderson. 2000. *The efficacy of paste baits containing micro-encapsulated zinc phosphide for the control of possums (Trichosurus vulpecula)*. Unpublished Pest Tech Contract Report, Prepared for the Animal Health Board. Lincoln, New Zealand.
- Spurr, E. B. 1994. Review of the impacts on non-target species of sodium monofluoroacetate (1080) in baits used for brushtail possum control in N.Z. Pages 124-133 in A. A. Seawright and C. T. Eason, editors. *Proceedings of the science workshop on 1080*. The Royal Society of N.Z., Wellington, New Zealand.
- Wickstrom, M., and C. T. Eason. 1998. *The development of alternatives to 1080 for possum control*. Landcare Research Contract Report No. LC 9798/42. Lincoln, New Zealand.